

Human Tracking and Location

Conceptual Design and Options Considered

ECE 403 - Senior Design 2

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Introduction

The purpose of our project is to devise a device capable of monitoring the entering and leaving of individuals to a building via RFID cards/wristbands and a stationary reader at the entrance(s). It addresses the problem of daycares or centers for those with special needs or assisted living for the elderly needing to find an administrator to check-in/out children/persons with disabilities/etc. and maintains a log of current occupants and those checked out removing the chance of an administrator updating logs, or passing on information of who is checked-in/out at any given time. This device will also help maintain a safe environment at the places we have listed by providing continuous monitoring of entrance and exit points.

Previous Work

Many hardware solutions exist, but software is very expensive for the market we are targeting. Current products are targeted at industrial and military applications where security is the number 1 concern. These solutions are not very cost effective for individual care centers that may be run from home.

After doing research in Google's Patent Search, we found several patents that describe similar behavior albeit not completely the same. The patent that most closely resembles this project is the following:

Name: RFID tag system for an item between two locations *

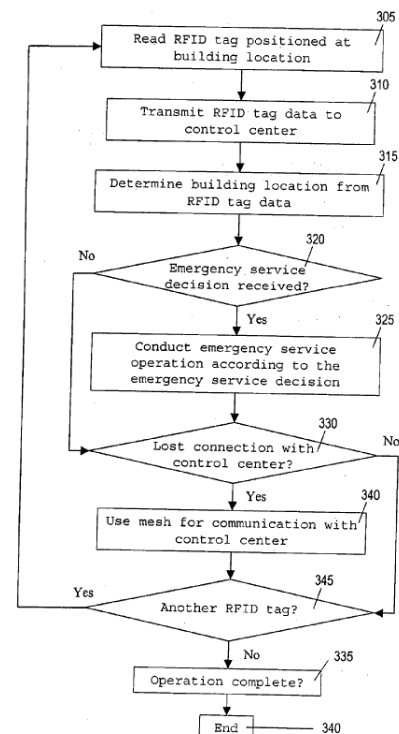
Application #: 11/098,798

Publications #: US 2006/0219783 A1

Filing Date: Apr 5, 2005

HTML Link: <http://www.google.com/patents/US20060219783>

* Block diagram (right).



Design Options

- Concept 1: As discussed in the requirements, there would be an open doorway with an RFID reader tracking individuals. Guardians would enter a passcode/matching RFID tags to allow them passage or else an alarm will sound.

Pros:

- 1.) Less hardware development, integration, and testing.
- 2.) Lower cost by using all commercial solutions, and no locking mechanisms or electronic controllers.
- 3.) Simpler design by reducing risk in custom hardware.

Cons:

- 1.) Less secure facility.
- 2.) Doesn't allow for automated checks on who leaves with whom or when.

- Concept 2: In addition to Concept 1:

- A locking mechanism on the door. The guardian would have a RFID tag which the system would recognize as a guardian. Only when individuals associated with the guardian were in range of the reader and a successful passcode entry would the door unlock to allow passage.
- A locking mechanism tied into fire alarms for emergency situations.
- Admin passcode override feature for emergency situations.

Pros:

- 1.) Better building security.
- 2.) Automated check for who leaves with whom.

Cons:

- 1.) More expensive than more software based solution.
- 2.) Higher cost with addition of custom hardware, development, and integration.
- 3.) More complex hardware design that requires custom solutions for proper implementation.
- 4.) Having a passcode entry has the potential to be very restrictive.

- Concept 3: Replace all previous mentions of RFID with GPS for use over a much larger range.

Pros:

- 1.) Better tracking than either Concept 1 or Concept 2 outdoors.
- 2.) Able to manipulate "go" "no go" areas without modifying, installing, or removing hardware.
- 3.) Only requires receiver bracelets, triangulation satellites already in place thanks to the US Navy.

Cons:

- 1.) More complex and in depth software development due to bounding

functions/area mapping, and interfacing with the satellites..

2.) Even more expensive to implement than Concept 2 due to use of GPS receivers and other custom circuitry required for every individual rather than the more complex device being the central device.

3.) GPS has limited functionality indoors due to material interferences in any given structure. More of an issue in commercial buildings, but can have issues in residential establishments as well in cases of brick/steel siding, basements, etc.

- Concept 4: Create and target RFID location system toward hospitals' nursery wings to add an automated security feature to prevent infant abduction and/or keep order of infants in nursery at any given time. We would utilize a continuous scan system to limit the amount of hardware installation to a number of RFID antennas (one or multiple) and an RFID driver/interface module to connect to the hospitals network and to the RFID antennas. The system would be capable of transmitting alert alarms to affected parties, including the parents upon entry of their child to the system. The parents/infants would wear color-coded passive/active RFID bracelets (depending on what we can find range wise in passive devices) with tamper proof wrist bands to prevent their removal. An optional feature of the system would be to allow the parents to be updated through email or a smartphone application of any new updates on their infant that may need immediate attention

Pros:

1.) Hospitals are larger establishments so funding is less of a concern as RFID technology is still rather expensive.

2.) This allows us to get our foot in the door with a product and a market favorable to early adoption while refining our design as component costs decrease.

3.) Once technology costs decrease to the point it is feasible for the average child-care provider to purchase a system for in-home use, we can adapt and target that market as well.

4.) Ease of installation

5.) Most of the functionality is implemented in software, with minimal reliance on hardware devices allowing for reduced down time in the case of a failure.

6.) Having a majority of the implementation be strictly software, the ease of updates to the system is maximized.

7.) No current fully automated systems in place to monitor location of infants in a hospital nursery, but rather, rely on the good nature and responsibility of those in charge of its operation. Current systems use matching bracelets with mother and barcodes.

Cons:

1.) Limiting our market by the cost of the system at present time, but expect to be able to implement a similar device for residential use as prices come down.

We are leaning towards Concept 4 due to variation and customizability away from prior art, along with the minimal number of foreseeable cons. Also, using an RFID solution, we do not have to worry about the additional cost, complexity, or indoor hindrances of a GPS based solution. Concept 4 also seems to be the most novel approach as there does not seem to be any solutions like it in the market today.

Tentative Parts and commercial hardware considerations:

RFID Reader:

Wavetrend L-RX202 Long Range RFID Reader - \$499.00

RFID Development Kit:

Wavetrend L-RX202 Development Kit: \$799.95
includes reader, tags, and protocol documents.
(probably our best bet for proof of concept)

RFID Bracelets:

Wavetrend TG1200 RFID Wrist Band Tag: \$69.95/ea.

GPS Receiver:

20 Channel EM-406A SiRF Receiver - \$59.95

Door latch:

Schlage FE595VCAM619ACC Camelot Keypad Accent Lever Door Lock, Satin Nickel - \$132.87

~~Wireless Modules (2): ~\$23/ea.~~

Not needed since looking to use dev kit for proof of concept.

~~Serial to USB chip: ~\$26~~

~~PCB Fabrication (3 attempts?): ~\$600? (assuming 2 boards per attempt @ \$100/board)
(ask Brad and Nate for cheaper options)~~ Not needed since going with active scan setup over access point control setup.

RFID Kits:

Name	Range	Data Interface	Multiple Passive/Active Tags	Price
Wavetrend Proof of Concept Kit L-RX202	450 ft	Serial/Ethernet	Active	\$799.00
MLX90121 Evaluation Boards	"Long Range"	Serial	Unknown	\$ 305.00
STMicroelectronics RFID Kit	"Long Range"	Serial	Unknown	Call for pricing (assuming very high price)
Long Range UHF RFID Kit	1 - 6 m	TTL Uart	Passive	\$ 289.00

The kit that gave us the most conclusive information to make a decision was the Wavetrend Development Kit. The rest did not have enough information to justify choosing them.

RFID Tags:

Name	Range	Passive/Active	Price
Wavetrend TG1200 RFID Wrist Band	"Long Range"	Active	\$69.95
RFID Bracelet-28 Read & Write LF/HF Wristband (RFID-in-China)	2-10 cm	Active	Unknown (Bulk Quantities)
RFID Bracelet-33 Read & Write LF/HF	2-10 cm	Active	Unknown (Bulk quantities)

The wristband to give us the best functionality for what we are looking to achieve is the Wave trend wristband, considering it is also 100 % compatible with the RFID reader we have chosen.

Budget Projection:

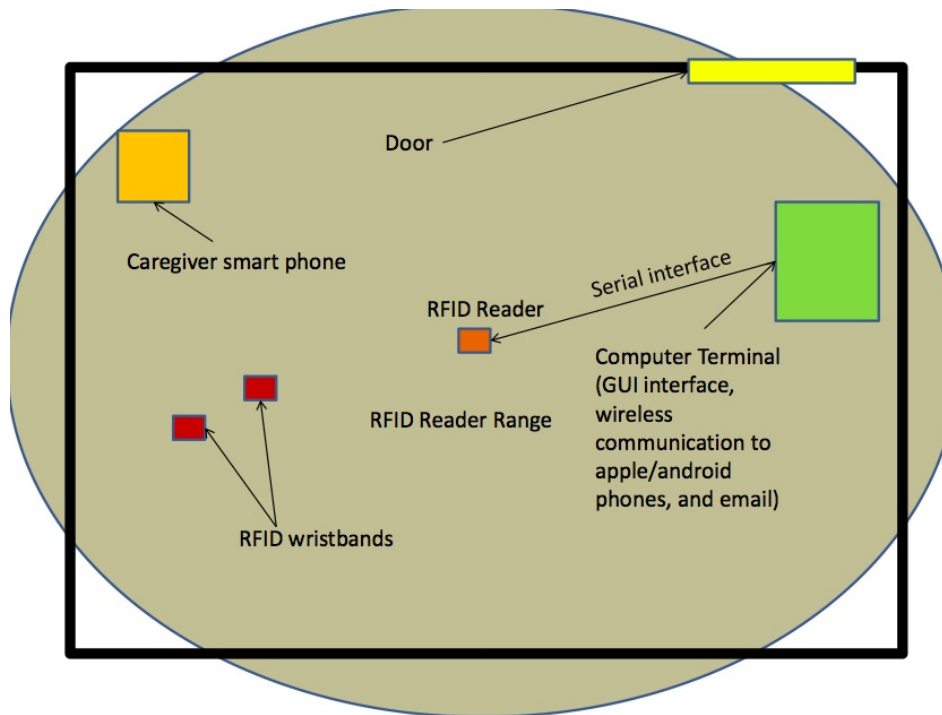
Concept 1: Roughly \$1500, budget projection for this concept is somewhat similar to that of concept 4 since it uses essentially the same components, but we have seen this implementation done before albeit at higher costs. The cost of this option upsets the novelty of the concept.

Concept 2: Total budget is roughly \$1700 exceeding that of concept 1 and 4 since it requires us to buy compatible locking mechanisms. Having a keypad on the lock seems to defeat the purpose of RFID tag matching between the guardian and the child under care. There is minimal novelty in this approach and that is why we decided not to proceed with it.

Concept 3: Assuming we use two sets of GPS receivers such as the one proposed in the budget above, the cost would be roughly \$150. Total budget for this concept seems to be the least expensive as the framework for GPS systems has already been put in place as well. The downside to this solution is that it would be absolutely useless in an indoor environment as we intended to use it. This option is the least logical of all the concepts proposed.

Design Choice: Concept 4 - Total budget of roughly \$1500 (based on above costs for items used in concept 4). This factors in \$800 for the dev kit, 2 additional wristband Active RFID tags, and a few dollars left over for any incidental/miscellaneous purchases. Ease of installation is maximized with this concept as there is essentially no complications to be had in wiring serial cables from the main antenna to our central station. We also plan on testing on our own Android/iOS devices to keep our budget minimal. After taking all of the options into consideration, this seems to be the most logical.

Concept 4 Block Diagram:



Timeline:

Job	Week	Who
Project Approval	1	All
Requirements Capture	2-3	All
----Type up from meeting notes	3	Peter
Options Considered	4-5	All
----Type up from meeting notes	5	Peter, Adam
----Propose Budget	4-5	All
----Propose Timeline	4-5	All
Finalize Budget and Timeline	5	All
Finalize Option from choices	6	All
Research Hardware Options	6-8	Peter
High Level Software Design	7-8	All

----Android/Backend	7-8	Adam
----iOS	7-8	Vir
----Embedded/Backend	7-8	Peter
Finalize/Order Parts	8	Peter
PDR1	9	All
----Hardware/Embedded/Backend	9	Peter
----iOS Development	9	Vir
----Android/Backend	9	Adam
Software Development (Skeleton Functionality)	10-12	All
Hardware Development	10-12	Peter
Power Consumption/Requirements	10-12	Peter
----Breadboard/PoC	12	Peter
PDR2	12	All
Hardware Revisions/PCB Layout	13-15	Peter
Continued Software Development	13-15	All
----Backend: Records entry/exit	13-14	Peter, Adam
----Android: Shows records	15	Adam
----iOS: Shows records	15	Vir
PDR3	16	All
----Code mostly finished ($\geq 75\%$)	16	All
----PCB Layout ready for Fabrication	16	Peter
BREAK	Week Reset	N/A
CAD design for hardware packaging	1-3	Peter
Finalize backend software	1-3	Peter, Adam
PDR4	3	All
Finalize Application Interfaces	4-6	All

----Computer GUI	4-6	Peter
----Android	4-6	Adam
----iOS	4-6	Vir
PDR5	7	All
Polish/Touch-up	7-8	All
Projected Deadline for Project Completion	8	All
Integration Testing/Debugging/Schedule Slip	9-16	All
PDR6	10	All
External Testing (Space Probe)	11-16	All
Finalize documentation	15-16	All
Final Presentation	16	All

Summary:

The project is a monitoring device utilizing RFID technology specifically designed for hospital nursery facilities to facilitate the accurate tracking of infants under their care at all times to prevent abductions/keep order. The system will communicate current information through a computer terminal GUI to one or multiple smart phones (iOS/Android) along with sending out automatic email notifications to registered addresses, and sounding alarms when triggered. In detail, the device will:

1. Utilize active RFID cards/wristbands and readers to monitor parents/infants entering/leaving the facility (wristbands/cards are worn/carried by all individuals being monitored).
2. To leave with their infant, a guardian must be wearing a matching secure wristband to allow the tracked infant to leave the nursery. If an individual without a matching wristband tries to retrieve an infant with a different wristband, an automatic alarm will sound indicating security personnel to make their way to the nursery immediately.
3. Wristbands are to be color coded as well as having matching IDs.
4. Wristbands are to be extremely secure with tamper-proof materials and inner workings.
5. The reader will be attached to a computer where a GUI will indicate individuals

currently logged into the system along with the times they entered/left the establishment as well as any time they come into contact with the infant.

6. Employees in the nursery will have access to Android/iOS applications that allow them to have full mobility and control in their hands at all times as well.

7. Parents are to have the option of having complete access to the most current updates of their infant.